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Coffee & Climate: The Geometry of Change

A Rapid Field Diagnostic of Coffee Farmers' Production Challenges in Cu M'ga district, Dak Lak, Vietnam

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For the Initiative for Coffee & Climate

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1. Mission purpose

The purpose of the visit to Buon Ma Thuot, Vietnam, was to initiate studies for the development of adaptation tools for smallholder coffee farmers of this central coffee zone. A central principle of the Initiative for Coffee & Climate is that adaptation tools must be appropriate to local environmental conditions and coherent with farmers' needs and capabilities. To this end, a programme of work has to be carried out to assess these factors and the visit was the first activity of this undertaking, using the methodology described below.

2. Background

The Dak Lak province is the principal Robusta producer of Vietnam, producing about 40% of the country's total output. The zone is subject to an intense dry season from December to April, when very little rain falls. Farmers rely on irrigation during this period which is mostly sourced from groundwater.

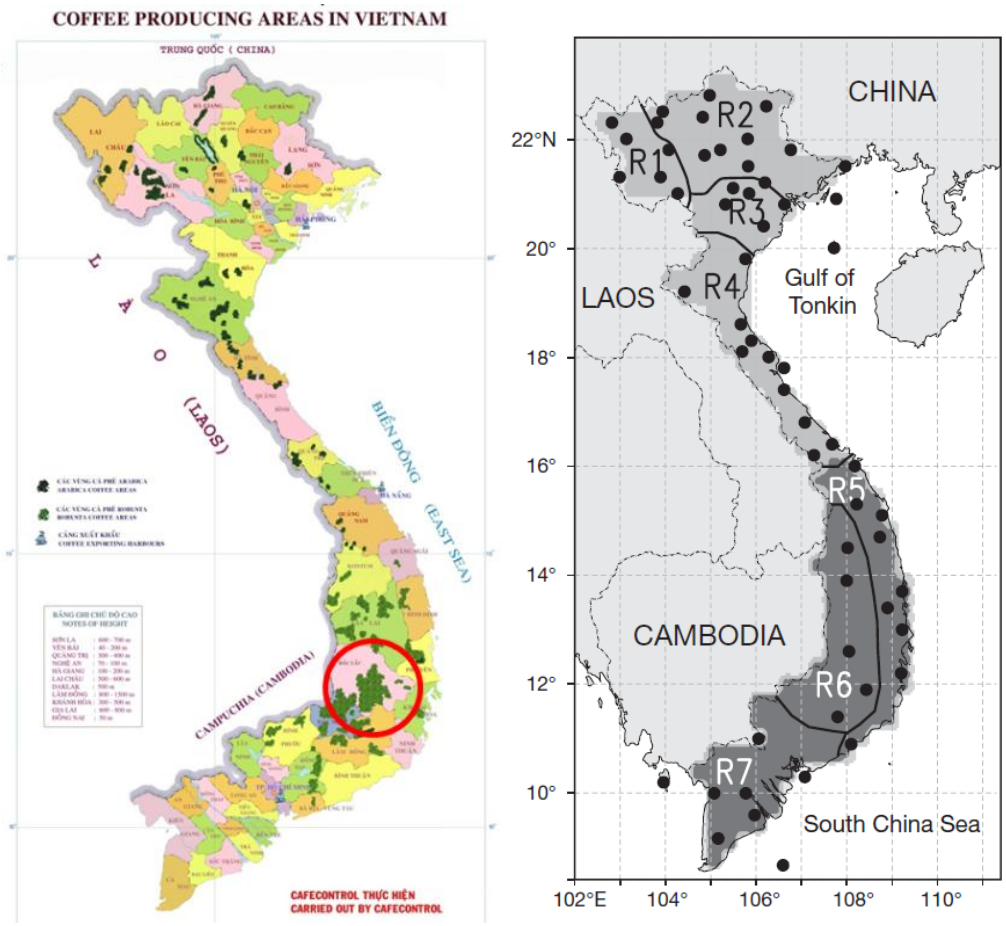

Figure 1. Left: coffee map of Vietnam, with study area circled. Right: zonal classification according to Thi Minh et al. (2011).

A detailed meteorological analysis of this area, oriented to variables of direct interest to coffee, is lacking. However a recent paper (Thi Minh et al. 2011) suggests that the central coffee zone, which falls within their R6 demarcation, has been subject to increasing extremes of temperature and rainfall which suggests that the extremes of wet and dry in the zone are getting worse.

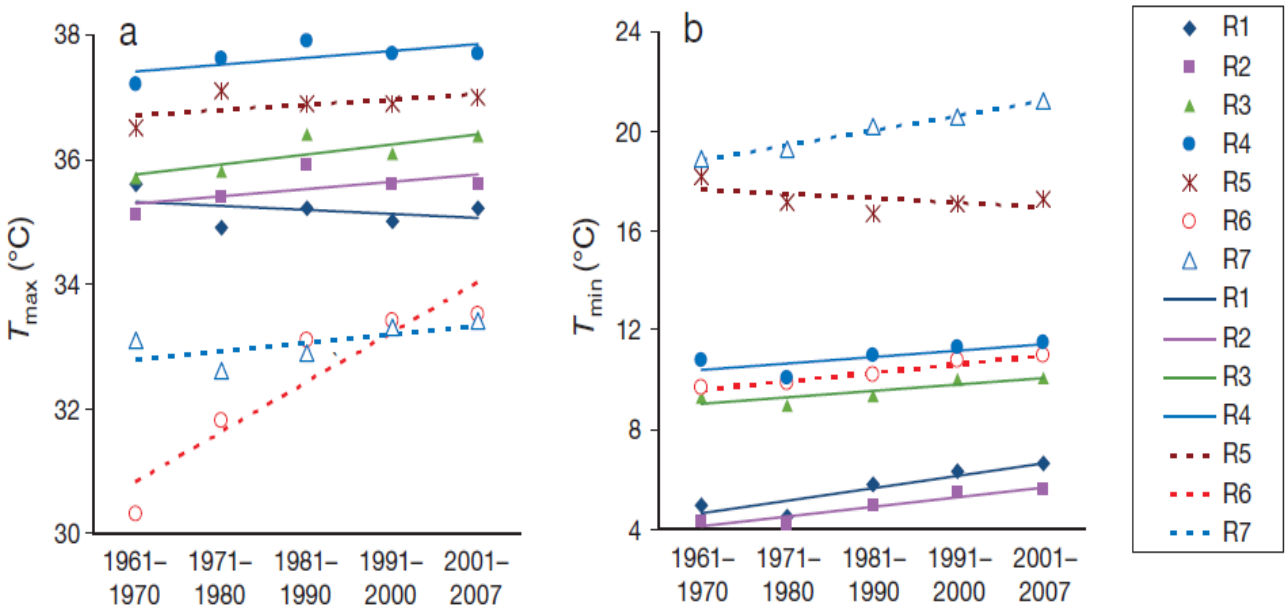

Figure 2. 95th percentile threshold (°C) of maximum temperature (Tmax) in summer (JJA) and (b) 5th percentile threshold (°C) of minimum temperature (Tmin) in winter (DJF) and their linear trend lines (Thi Minh et al. 2011).

3. Methodology

The basic approach was a 'triangulation' method to evaluate different sources of information:

- local experts
- farmers (including farm visits to inspect the state of growing coffee)
- available scientific knowledge

If data collected from all these sources has a large degree of overlap (i.e. agreement), then this gives confidence that our findings reflect current reality, based upon the best possible evidence available (Fig.

3). If the various sources conflict, then further investigations are necessary to discover the sources of any uncertainties.

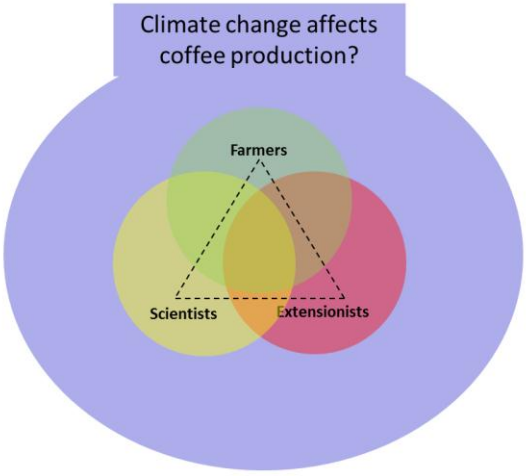

Figure 3. Triangulation: coherence of evidence from farmers, extensionists and scientists on the effects of climate is sought.

4. Findings

4.1 Farmer diagnostics (Cu M'gar, near Buon Ma Thuot)

Interviews

Individual interviews with 25 farmers in the Cu M'gar district were carried out in meeting halls and a farmer's house. These interviews were informal, but followed a predetermined structure and lasted about 20 minutes each. The primary aim was to objectively assess their production problems and determine to what extent climate change might be a part of them. Farmers were not informed about our interests in climate change and questions were not specifically oriented towards this subject. Answers were entered on a form (see Appendix 1).

A one day farmer workshop with 22 attendees was also convened, where various group exercises were undertaken, to elicit further information and to start the process of participatory discussion of production problems.

Salient results of farmer interviews: from interviews, on being asked about their main production problems, nine problems were raised, the frequency of which can be seen in Figure 4 below.

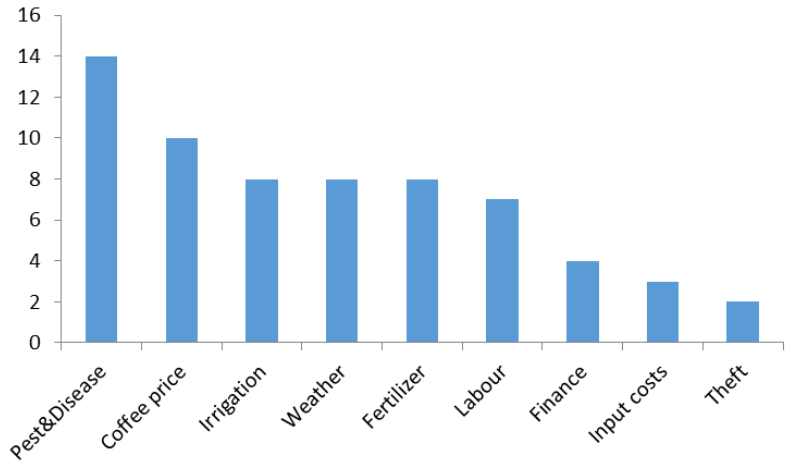

Figure 4. Frequency of production problems mentioned during interviews of 25 farmers in Cu M'gar

Weather, irrigation and pest and disease problems may all be directly or indirectly linked to climate change.

When farmers were asked 'what changes have you seen since you have been growing coffee'? 60% mentioned changes in the weather.

Statements made by farmers reflected a wide range of opinion:

The weather has changed a lot
The rains come at the wrong time
The weather is unpredictable - I used to know what to do each month
I've seen no changes in the weather
The weather is better now
The weather no longer meets my expectations

Pests seem to be an especially prominent problem: many farmers went out of their way to say how they either didn't apply chemicals or applied them only sparingly. But these answers sounded a bit too trite – had they recently received training on this subject? When asked whether they intended to continue in coffee in the future, only one farmer out of 25 said he was thinking of switching entirely to another crop. This farmer was, however, probably the most intelligent and well-informed person interviewed.

Farmer Workshop
Farmers were asked to indicate their level of content/discontent about a range of issues that were mentioned during interview sessions. They were invited to enter a cross below one of the five faces for a range of production issues.

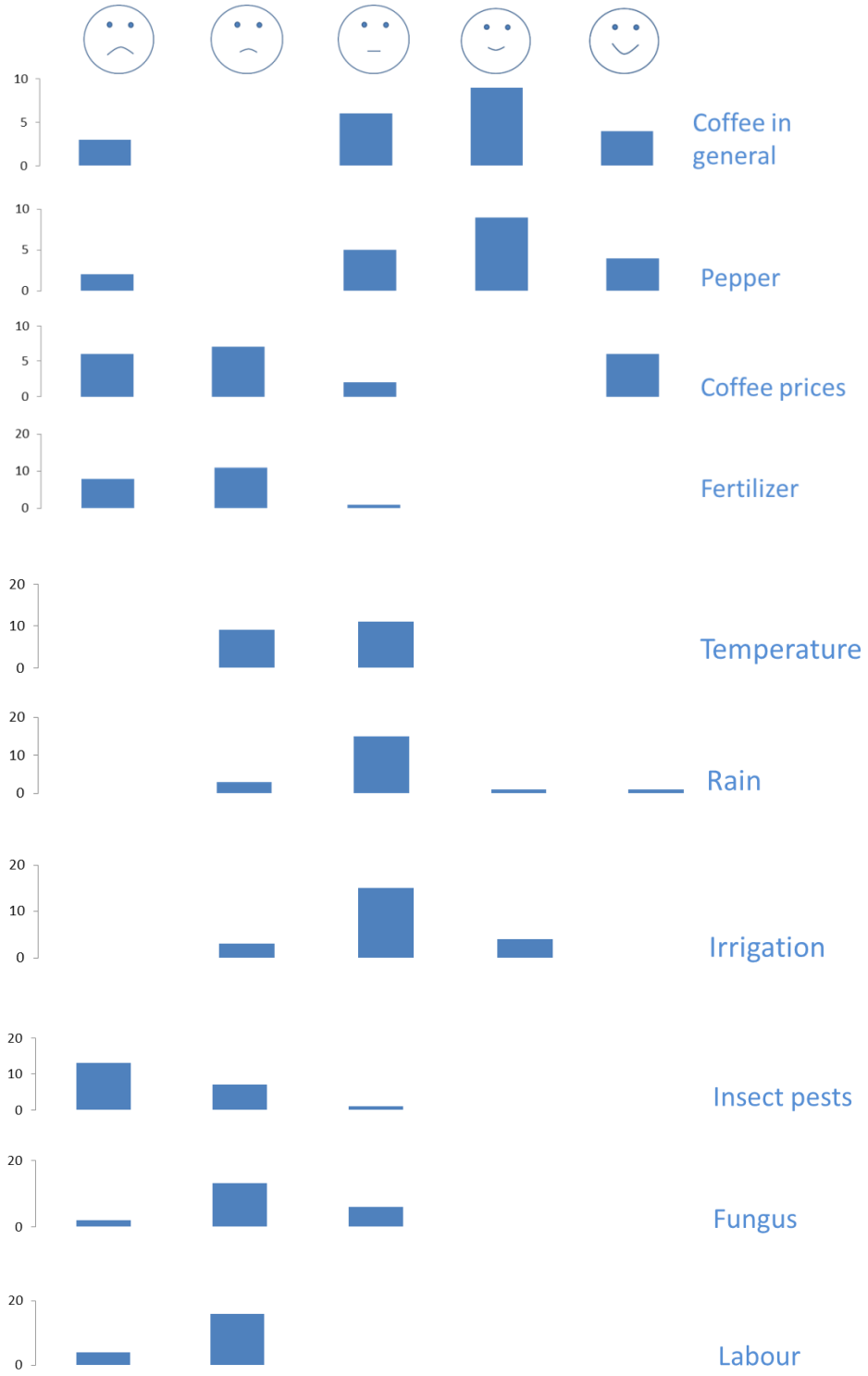

Figure 5. Results of a workshop activity to gauge level of content/discontent with a range of coffee farming factors.

These results from the workshop, quite closely reflect the level of concern expressed during interviews. Farmers are broadly happy with coffee farming; they have some concerns about weather, but are more concerned about the usual preoccupations of labour and prices. Farmers were most unhappy about fertilizers and, surprising perhaps, insect pests.

What are farmers already doing to adapt to climate change?

Irrigation – farmers have always irrigated in this zone, and in the face of drought they simply carry out additional rounds of irrigation and dig more wells. This is not a sustainable approach and they should be encouraged to apply less water since they are almost certainly over-watering to a considerable extent. However, because water is free, there is no incentive to reduce applications, so this will be a challenging goal.

Diversification – farmers seem to be partially diversifying. Many farmers now have pepper vines, usually one row per 4 to 6 rows of coffee. A few farmers have fruit trees such as durian and at least one farmer has made a good profit from this over the past year.

Conclusions from farmer interactions
Weather problems are of concern to farmers, but not a principal worry. This is corroborated by the high mean production figure of 3.85t/ha (range 2.5 to 5.2; n=25) reported by farmers during interviews, hence weather cannot be causing significant losses.

Nevertheless, they seem to be experiencing increasing problems in obtaining sufficient water, due to falling groundwater (affecting amount that can be drawn from wells) and insufficient surface irrigation water, especially towards the end of the dry season and especially for those who are distant from water sources. Continuing climate change is likely to make these problems worse.

The concern about pests and diseases is more difficult to understand and needs further investigation. Questions that need answering are:

- Do the pest and disease problems actually cause loss in production?
- Which pests and diseases are the main problems?

- Are they spending a lot of time and money on inputs?
- Are they especially concerned because some of these problems are of recent origin and they do not know what to do?

4.2 Expert opinion

For the second part of the 'triangulation' a range of local experts were consulted.

Department for Agriculture and Rural Development (DARD)
The Head of Planning and Production was interviewed. He agreed that although farmers were very experienced, new problems have emerged in recent years due to unstable weather. This includes unpredictable weather at times of flowering and drying. Water levels are declining and without adaptation efforts to reduce water use, there will be a very negative impact. The problems are widespread and adaptation will be a long and difficult process. Training about climate change and adaptation is a necessity. He affirmed that diversification will be increasingly necessary.

He also mentioned that the official plan is that by 2020 the coffee area in Dak Lak should be reduced from 200,000 ha to 150,000 ha. Areas for reduction have been identified and should be made public by September 2012.

Department of Science and Technology (DOSTE)/Buon Ma Thuot Coffee Association
Standing Chairman Trinh Duc Minh asserted that climate change was very clearly reflected in water scarcity. To date there have been no successful solutions to water saving. He felt that drip irrigation would not be successful, and that efforts to reduce the area in coffee would be also be difficult to carry out. He mentioned that a new clone TR12 which exhibits delayed ripening is becoming available, but because of the theft problem, this is unlikely to be of much use (theft was also mentioned during farmers' meetings and the response is to guard their plots around harvest time and pick early, which compromises quality).

West Highlands Agricultural and Forestry Research Institute (WASI)
A meeting was held with the Director of International Cooperation and the Director of Science. They informed that for the Vietnamese government, the Central Highlands is not a priority area for climate change, because problems in coastal areas are more profound and directly affect food production. WASI seem to be addressing the carbon footprint problem of coffee, but have no data available on this.

On the details of climate change, average temperatures have increased very little, a bit higher in the dry season. Now the rainy season is longer, but this phenomenon is not very visible. The rains can last into the harvest season, causing drying problems.

In 1998-9 there was a very intense dry season lasting six months (this was a globally intense El Niño year) which affected bean size and yield; the rain came late in June 1999. Normally farmers do three rounds of watering, but that year they did six.

WASI have no drought resistant varieties, but confirmed a delayed ripening variety. However this may not be successful because it could delay ripening into the Tet festival when labour would be scarce.

The director thought that if the meteorological evidence is correct, that rainy seasons are getting longer, then this will generally be good for coffee because it should reduce water scarcity, though it may well also lead to more pest and disease problems. Stem canker and stem borer are now more common than previously.

He believed that farmers were tending towards more diversification through intercropping; 4C, Utz, Rainforest Alliance all support diversification. He informed that Japanese researchers visited last year and found coffee beans infested with *Aspergillus* fungus – presumably from harvested berries.

Water saving technology has so far not been successful; his opinion was that the cost of a drip system is high and there is the risk of theft if above ground.

Provincial Extension Centre (PEC)
Two representatives of PEC were interviewed. They believe that there are very visible signs of climate change, especially in 2012 the climate is 'strange' with rainfall so far lower than last year. In five or six districts they are suffering from drought. They felt that farmers are the hardest hit by climate change and that adaptation is difficult. They firmly believed that extensive reforestation is necessary and that farmers should be encouraged to plant shade and windbreaks. In colonial times the French introduced a good system and that this should be re-adopted. Three things to reduce are water, fertilizer and insecticide use. More organic fertilizer should be used.

Rainfall is a problem during drying, leading to quality losses, hence they believed that a simple drying system for farmers is needed.

Pests and diseases are not very serious but believed that cicadas are getting worse due to lack of shade. Mealy bugs are also a problem.

They said that although diversification is a good thing, farmers should not be encouraged specifically into pepper because current prices may not last. On poor soil coffee should be diversified to cocoa, which requires less water, partly as an adaptation strategy. It is not easy to transfer technology to farmers who farm in so many situations. PEC are focussed on awareness training.

There is a 'golden time' when farmers listen to their radios at around 6.00 a.m. – i.e. this is potentially a good time for extension messages to be transmitted.

DONRE Department of Natural Resources and Environment
The deputy manager and water resource manager were interviewed.

No study has been carried out on the impact of climate change on agriculture in the region. They have no data about climate change, only perceptions. There has been a lot of change in climate, both

temperature and rainfall and a thorough survey is needed. Rainfall has changed a lot, groundwater levels have fallen. Streams and rivers are sometimes very low in the dry season – by April you can see the bed of the streams. Also, nowadays people exploit groundwater much more, almost all farms extract groundwater.

'Initiation' workshop
Conclusions from the farmer meetings were put to experts at the initiation workshop, with the caveat that these were preliminary conclusions from only one locality. Discussion after the presentation elicited agreement (with no dissent) that the problems identified with farmers were indeed an accurate reflection of farmers' current problems.

Conclusions from expert encounters
There was very broad agreement that the climate is changing, though it is not entirely clear what has changed. One expert believed the changes could be beneficial because the rainy season is now longer.

Water scarcity was evidently a key worry, perhaps more urgently expressed than by farmers.

There was also broad agreement that adaptation options are few and that efforts to data have not been successful.

From these meetings it seems there is a clear need therefore for more surveys to clarify the true extent of problems, more experimentation on adaptation options and extensive training.

One major difference from farmers' opinions was that quality loss through drying difficulties was mentioned several times by the experts. Perhaps farmers do not see this as a special problem since there is not a well-established premium for properly-dried coffee? Additionally, despite the evident severity of the 1998-9 El Niño event, farmers did not refer to this event during interviews.

4.3 Scientific data

The third part of triangulation is to assess the available scientific data to guide us on how the climate may be changing in the coffee zone

Meteorological data
Existing data confirms that mean temperatures have been rising in Vietnam over the past three decades (UNDP 2005: Figure 6.) and as mentioned above, there is convincing data that more extremes of temperature and heavy rain are occurring in the central zone that includes Dak Lak (Thi-Minh et al. 2011).

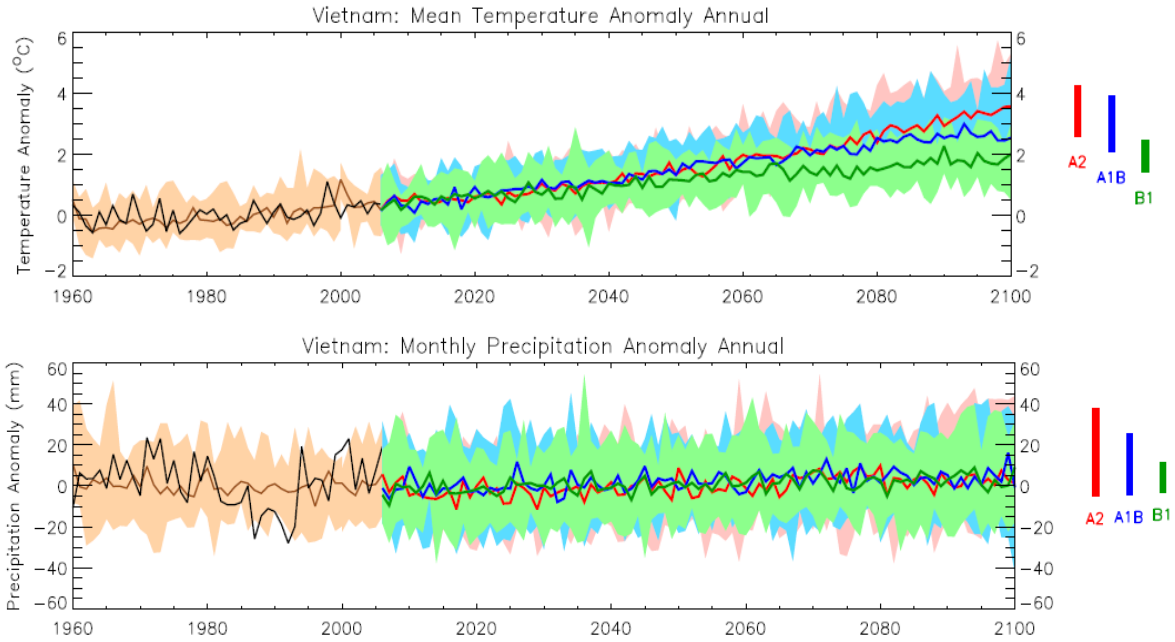

Figure 6. Climate projections for Vietnam show an accelerating temperature trend but no clear rainfall trend (UNDP, 2005)

However, insufficient data is available at present to determine whether there have been changes in the wet season (key variables for coffee growing are its time of onset, duration, intensity and intermittency). There have undoubtedly been drought problems over the past few years, but there is no way of knowing whether these are part of natural variation or are showing a long-term trend.

Irrigation – water shortages

There is widespread belief that groundwater levels and above ground water supplies are declining, supported by scientific evidence (e.g. references in D'haeze et al. 2005) though seemingly there is little recent data on this. If possible some effort should be made in the present project to collect it and to solicit support/collaboration from one or more of the expert agencies interviewed.

Pests & diseases

There was a surprising amount of concern about pests and diseases expressed by farmers, which was not reflected by our impressions from visiting coffee plots nor stressed by experts. Indeed, rather few pest and disease problems were seen: a small amount of die-back probably due to overbearing, a few chlorotic plants, which may reflect either nutritional or root pest problems, but little else

There is no scientific evidence available so, as for water, some data collection is needed. However to achieve this under the tight time-frame of the existing project could be too difficult.

5 Hypotheses

Based upon the information collected above from farmers, experts and available scientific evidence hypotheses about the climate change problem in this region can be developed:

H1 Temperatures are rising with more hot days and hot nights which will lead to increased evapotranspiration and increasing incidence of some pests and diseases.

Evidence for hotter temperatures exists, but there is no objective supporting evidence that pest and disease are increasing and that this is caused by climate change.

H2 Rainfall is more unpredictable and/or intermittent than formerly. This leads to problems with flowering and drying of cherries.

There must be evidence for this in the meteorological data which should be quite simple to ascertain.

H3 Groundwater levels are falling and rivers and streams are drying up during the dry season. This is due to increased demand, increased evaporation and possibly changes in rainfall distribution and intensity.

Supporting data is needed – local institutes ought to be collecting this sort of data as routine (groundwater and river depths). If possible, the project should initiate this data collection and encourage local institutes to carry on doing this.

H4 Farmers are overwatering – they could cut their current levels (c.500L/tree/round) to as low as 300L without suffering production losses or stressing trees unduly.

Evidence for this already exists but should be further tested during this project – to produce ways of convincing farmers, as well as some estimation of their willingness to adopt a water-sparing attitude.

H5 Increasing shade will reduce incidence of cicadas and protect the coffee from high temperatures.

There is no evidence to support this – experimentation on shade is beyond the capabilities of the current project, but if areas are located where coffee is shaded, or where coffee is close to stands or banks of trees, these could be useful places to collect data on pest incidence, drought problems etc.

H6 Despite problems, farmers in this zone are well buffered against climate change. They produce a substantial amount of their own food, their soil is good, their land is mostly flat and not subject to great erosion or landslides. They therefore have a high level of adaptive capacity and could cope well with increasing climate extremes.

This is something not explored adequately during the visit, but it would be important to assess this aspect. In the present project it is expect to concentrate almost exclusively on coffee adaptation and it is expect that farmers can cope well – i.e. that they will not suffer hunger due to climate extremes. It would be important to justify this assumption however and therefore the interview form has been

modified to capture data about self-sufficient food production (Appendix 1). Further questions about this could be added according to subsequent interview experience.

6 Project activities

The following project activities are suggested. Based on the need for more accurate and relevant information and to show progress on development of tools relevant to farmers needs and circumstances.

Meteorological information

All available meteorological data from the coffee zone should be collected, analysed and mapped to give an up-to-date, accurate and visual impression of current climate variables of interest to coffee growers. This would include maximum and minimum temperatures, precipitation levels (annual and month-by-month) and sunshine levels. If funds are available, this should be done with a meteorologist, preferably Thi Minh et al of Ha Noi University because they have already shown they are capable of producing quality work in English.

Groundwater levels

The large number of wells dug by farmers on their land affords the opportunity to collect data about groundwater levels. To complement the meteorological mapping, it would be very useful to be able to obtain readings of water depth with a view to mapping out groundwater levels. If it were practically possible to identify, say 50 to 100 wells in the zone of interest, georeference them and then measure water levels twice (end of wet season, end of dry season) this would give useful data on groundwater levels.

Soil data

If the groundwater survey can be done, it is recommended to also take a soil sample from the coffee plot in which the well is situated, for pH analysis, using a cheap, standard gardeners' kit. Seemingly there is little available data on soil acidity and this would be a quick and inexpensive way of collecting it. If more resources are available, full soil and leaf analyses should be carried out, to include soil organic matter content.

These three sets of data (meteorological, groundwater and soil) together would provide much useful information about the overall health/vulnerability of the coffee zone and as such help to determine the level of potential exposure to climate related problems. Together these effectively amount to a soil and water risk assessment tool which should aid support institutes to plan future activities. If at all possible, the work should be shared with these institutes with the understanding that the measurements should be eventually taken over and run by themselves as a routine activity.

Farmer data

Both interviews and workshops provided very useful data about problems affecting farmers. More data should be collected from across the zone, to get a comprehensive view of the region. Farmer interviews are preferable because this makes a subsequent field visit more feasible to gauge general health of the coffee including pest and disease incidence (and locate wells for future inspection). Number of places to

sample will depend on resources, but a transect from the lowest lying areas (approx. 350m) to the highest (approx. 850m) is strongly advised. Interviews can be conducted in about 20 minutes, hence 15 to 20 interviews per day are possible and this would be a sufficient number for a single locality.

From the results of the interviews already carried out, some modifications have been made to the interview form.

Land cover, land use, effects of climate change on hydrology
It would be useful to obtain a better understanding of land cover and land use change in this zone. Deforestation and land use change were mentioned by experts especially but little information has been found by this consultant. NKG Statistical Unit may have some satellite maps and if so, these should be made available to EDE in Vietnam.

Additionally, further work could be undertaken, such as that carried out recently for the Be River catchment by Dao Nguyen Khoi & Suetsugi (2012) who developed land-cover maps of that basin from the Advanced Very High Resolution Radiometer (AVHRR) Global Land Cover Characterization (GLCC). Efforts should be made to meet Dao (based at the Faculty of Environmental Science, University of Science Ho Chi Minh City) to discuss feasibility of joint hydrological studies in Dak Lak similar to what was done for the Be River. Although such work may well not be possible for the present project, initial contacts to discuss the feasibility of future activities should be considered.

Organizing farmers
As suggested by the EDE team, it is very important to engender greater self-organization by farmers to confront the problems they face. This is entirely consistent with the now fashionable (amongst donors and NGOs) community-based adaptation (CBA) approach such as promoted by CARE International (2011, 2012), IIED (Chishakwe et al. 2012) and CGIAR (Sova et al. 2012). This is also consistent with Coffee & Climate Initiative's perspective that tools should include some that deal with a larger scale than the single farm unit.

The consultant recommends making contact with CARE International in Vietnam to learn more about their CBA activities, perhaps to attend a practical session/workshop, in order to see if there is anything relevant that can be applied to the present project.

The possibility of securing lower prices for fertilizer inputs by working together is a good opening activity where a quick win can be gained, to encourage group cohesion and pave the way for the more difficult activities of adaptation. An alliance with Yara, who claim that their products have a lower carbon footprint, would also serve to enhance the climate credentials of this activity.

Since the local EDE team already have prior experience of farmer organisation in Dak Lak, the consultant feels that no further guidance need be offered here on the formation of farmers' groups.

Experimentation and tool development with farmer organisations
It is suggested that the focus of work to develop tools should concentrate mostly on water and soil related issues:

- Dealing with insufficient water supply during the dry season
- Soil nutrition, root depth, pH, organic matter, etc.
- Irregular rainfall leading to drying difficulties

If possible, some resources should also be devoted to learning more about the pest and disease problems too, in the first instance by more detailed questioning of farmers and/or workshops over precisely what are the problems, when they manifest themselves, how much time and funds farmers spend on controlling them and how much lost production is caused.

Soil horizons
If possible with each farmer group one or more trenches about 2 m deep should be dug to observe the root depth of established coffee trees – how shallow are they? How dry is the soil below the surface zone? Some of the trees have been in the ground for 25 years, so it would be interesting and instructive to see what sort of root structure has developed.

Where possible this should be initiated with farmers who are planning to replant their trees, in order to avoid possible damage to roots of trees in production.

This activity should help to gauge the general health and potential sensitivity of coffee to a major drought and additionally be a useful training tool.

Ground cover/landslide protection
On the face of it, because of the fairly flat terrain, the irrigation concavities and almost total cover of the trees, mulching is unlikely to be a useful option. On steeper ground erosion may be more of a problem, but this was not encountered on the present trip. If this is found to be a problem with selected farmer groups, then activities to stabilise soil, through grass strips for instance, should be considered.

Tool development - water sparing
From discussions with Dave D'Haeze, it seems certain that farmers are over-watering, hence there is scope to reduce the amount applied – e.g. to 300L/tree/application. Therefore some field experimentation (e.g. through a farmer field school set-up) can be set up to try this. As suggested by D'haeze, to estimate the water volume applied, farmers can estimate the time to fill a 100 L barrel with water then time their watering activities to estimate total volume applied.
Farmers selected should be those who are far from the water source and already experiencing difficulties. Farmers who are near the source will have little incentive to reduce consumption because water is free.

However, in the future this situation may change. Water will almost certainly become scarcer and a convincing demonstration of water reduction potential for coffee will be of great use in the future, even if initial uptake is poor.

Some trials with farmers' normal application rate, plus applications reduced by say; 10 to 30% could be tried on small groups of trees. Soil samples should be taken at regular intervals to measure soil moisture, to check whether reduced applications lead to excessively reduced soil moisture levels.

Tool development - water retaining hydrogels
Absorbent gel material is now available and inexpensive in Vietnam, so it is therefore feasible to carry out some tests to see whether application of this material might be able to increase the water-retaining properties of the soil during the dry season. Some initial tests, applying the material down a piece of plastic piping to a depth of, say 50 cm, could be tried.

Trials should be initially on:

- Demonstration seedlings in pots: to show that those plants with added gel grow at the same rate as normal seedlings but need to be watered less often

- Old trees: for farmers who are contemplating replanting, an agreement could be sought to delay this and try out some gel application experiments.

- Planting out stage: to start on farmers' fields or garden with very small trials (one to five seedlings) with added gel just below the planting hole.

Tool development - cherry drying
A problem that was mentioned, especially during expert interviews, was the difficulties of drying cherries, both because of lack of space and rainfall during the harvest season.

This seems to be a difficult problem to solve – farmers temporarily need a large surface area because the volumes they harvest are large and they may also need increasingly to be able to cover the berries, e.g. with tarpaulin or parabolic dryers. Additionally any area used needs to be secure because of the problem of theft.

There are no simple solutions to this problem, but the subject should be addressed initially through a farmer workshop to a) establish how serious the problem is; b) facilitate a brainstorming session to look for potential answers, c) draw up a plan of activities for the most promising solution.

It seems unlikely that farmers individually can solve this problem, hence this is a further incentive to prioritize farmer organization activities.

If initial group activities – e.g. to reduce fertilizer costs – are successful, then this might encourage participants to take on more difficult problems such as drying.

Possible solutions might be to collectively rent a space (e.g. unused business/factory/public building space), as well as transport and security. I.e. it is innovations in logistics that may be most needed to solve this problem and these would therefore be the main part of any tool.

Drying tools: tarpaulins and parabolic coverings for rain protection and accelerated drying
One or more of the latter (made from curved bamboo and polythene, like a large poly-tunnel) could be quite easily constructed and their utility assessed. However, these were designed for smallholders handling low volumes of higher value Arabica beans, as opposed to the industrial quantities of low value Robusta cherries that have to be dried in Vietnam, so it is unlikely that this tool would be of much use.

7 Conclusions
There are a large number of potential activities that could be carried out, but because of time constraints advances cannot be expected in all areas.

It is recommended that:
A] Meteorological data for Dak Lak should be collected and analysed to evaluate whether there is any sign that the dry and wet seasons are changing in length or that there are more intermittent rains now than previously. Total rainfall can also be evaluated but because of inherently large annual variation, it is most unlikely that there will be convincing evidence of a trend emerging. Partners to carry out this work should be sought, either at Ha Noi or Ho Chi Minh Universities.

B] Further farmer surveys, covering the widest possible range of altitudes, should be carried out, preferably at least 10 points. At the lowest altitudes, evidence should be sought for farmers who have abandoned coffee in recent years – if possible these farmers should be interviewed, since their problems will be a guide to those to be faced by current farmers in future years. Generally it is expected that more climate related problems would be apparent at the lower altitudes, so it is important to sample this zone, which will contain the first farmers to abandon coffee altogether.

C] A groundwater survey (twice a year) to determine the true extent of suspected water level declines.

D] More attention should be paid to finding out the degree of pest and disease problems encountered by farmers, since the present situation is far from clear. Initially this should take the form of more detailed questioning of farmers. Specific surveys may be necessary, but these can wait until more is understood about the problem.

E] Detailed work with farmers should concentrate on a few groups of farmers, at least three if possible, in different localities, to carry out a range of activities:

I. Forming an organisation – workshops, training and discussions on forming a durable and workable farmer association.

II. Securing reduced fertiliser rates and/or better quality fertilizer – this is the confidence building first step to encourage farmers to collaborate long term on some potentially difficult/unrewarding tool development work.

III. Assessing pH levels and where possible full soil and leaf analyses to determine the present state of soils.

IV. Field activities (field-school and 'one-off' experimental trials) to reduce water usage, assess coffee root conditions and soil (soil profiles).

V. Brainstorming sessions on coffee drying – with follow-up activities.

Five tool outlines can be found in Appendix 2.

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Appendix 1 Farmer interview form

Date		Location	District			Farm name	
			Municip			GPS	
			Soil type			Altitude	

Farmer	Name	
	Age	

Fazenda	Farm size (ha)	
	Main coffee var.	
	Tree density (apprx)	

Plot	1st	2nd	3rd
Yr started			
Size			
Coffee			
Intercrop			

Problems	tick boxes: Climate	Pest	Disease	Finance	Labour	Irrigation	Other	synopsis of comments by farmer
Principal current problem								
Second problem								
Third problem								

Food crops	Yes/no			
Do you grow your own food?		If so, how much of your basic requirements are covered?		%
		How much time a week is spent on food production?		hrs

	synopsis of comments by farmer
What changes have you noted in coffee farming since you started (any aspect, env., social, economic)	
Future: do you intend to keep growing coffee?	

Visual (state of farm from 5 min walk)

	tick boxes				brief observations (use key words)
Coffee health	Poor	So-so	Good	Excellent	
Shade or intercrop	None	Light	Medium	Heavy	
Intercrop health	Poor	So-so	Good	Excellent	
Plot has a well?	Yes	No			
Erosion	None	Little	Medium	Heavy	

Global impression of farm [1 = very bad to 10 = exceptional]

Farmer innovation

Other comments (be brief)

Appendix 2 - Tools for the specific context of Vietnam

Tool: evaluation of groundwater levels in coffee watersheds.

Type: Landscape, assessment tool
Feasibility: high – based on a study carried out in a coffee watershed
Applicability: to be carried out in all areas where irrigation is a common practice
Effectiveness: no data

Concept: to directly monitor water levels in wells
Activity: identify and visit local wells across the coffee zone, record GPS data for future reference, measure water depth using a weighted rope. Carry out twice per year to coincide with expected high and low water levels.

Tool: risk assessment of groundwater extraction in coffee watersheds.

Based on a paper by D'haeze et al (2005)

Type: Landscape, assessment tool
Feasibility: high – based on a study carried out in a coffee watershed
Applicability: to be carried out in all areas where irrigation is a common practice
Effectiveness: no data

Concept: to monitor water levels, in order to warn decision makers if serious depletion is taking place, it is possible to calculate a water balance from estimates of surface runoff, crop evapotranspiration rainfall and irrigation returns.

Activity: as described in D'haeze et al.
The assessment involves a water balance approach, which is calculated as the annual groundwater recharge (G) in the water balance equation (Eq. (1)). Rainfall and irrigation return flows constitute the principal sources of groundwater recharge. Recharge from rainfall is calculated as the annual precipitation minus surface runoff (RO) and crop evapotranspiration (ET_c), while irrigation return flows represent deep percolation (DP) of irrigation water below the root zone of coffee during the dry season.

$$G = (P - RO - ET_c) + DP \quad (1)$$

It is thereby assumed that precipitation and irrigation return flows are the only recharge components of the aquifer, i.e. there is no leakage from streams or underground channel flow to the groundwater and that the soil water storage is steady so that changes over a long period can be considered zero. The monthly precipitation records over a 20 year period are needed.

DAVE D'HAEZE TO REWRITE THIS TOOL ACCORDING TO THE NEEDS OF THE PRESENT PROJECT

Tool: forming community watershed management organisations

Type: Community/landscape
Feasibility: high
Applicability: to be carried out in all areas where irrigation is a common practice
Effectiveness: no data

Concept: to organise farmers to develop community solutions to coffee production problems, especially those related to water scarcity.

Activity: SINCE EDE ALREADY HAVE EXPERIENCE WITH THIS, THEY SHOULD COMPLETE THE DOCUMENTATION OF THIS TOOL

Tool: Water-holding polymer tool for nursery material and planting out

Type: resilience
Feasibility: high – commercial products for this already exist in horticulture
Applicability: needs trialling, especially in regard to CBA
Effectiveness: Some initial results with coffee in Brazil (Carvalho et al. 2011)

Concept: Water absorbing polymers are used in commercial nurseries to promote plant growth by reducing desiccation. Typically they cost less than €0.01 per 2g dose. They may be useful to reduce water stress on newly planted coffee trees and/or shade trees. Potentially they could also be added to the root zone of mature trees by extracting a core of earth with an augur, inserting a plastic tube and then pouring down a dose of the absorbent material.

Activity: field trials on individual trees, especially old trees that are soon to be replaced.
Drawbacks: chemical composition of the Vietnamese granules is currently unknown. Polymers based on acrylamide may not be suitable due to risk of toxic accumulation in groundwater.


Tree with watering tube

Tool: Cherry Drying

Type: resilience
Feasibility: High
Applicability: everywhere that has experienced problems with coffee drying
Effectiveness: high except possibly in areas where ambient humidity levels are high and there is little wind

Concept: simple and relatively cheap devices to cover coffee during the drying process

Activity: construction with wood and plastic. In the figure below the parabolica is combined with large shallow drawers made of wood and mesh that can be slid under cover if rain starts. Either device can be used to protect coffee from rain, though it is unusual to see both used together. Compare effectiveness with traditional methods (plastic tarpaulin).

Drawbacks: may not be cost-effective for high volume Robusta cherries